Congestion Management Workshop
Session Four:
Congestion Management and
Pricing Models

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Overview

This session focuses on a discussion of four market models.

- **IndeGO**
- **Physical Rights Models (e.g., Desert STAR, Mountain West)**
- **Financial Rights/LMP Models (e.g., PJM, New York, New England)**
- **California**

While many approaches are under consideration in other regions of the country (and the world), this group of models captures the variety of the options available to the RTO.

To understand how each of these models works, you should focus on understanding how each of the following questions would be answered by each model.

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Real-Time Balancing Market

How does the RTO provide open access to a real-time balancing market?

- **If the RTO arranges for energy for real-time balancing, how does it determine which providers should produce the additional energy?**
- **If the RTO provides a real-time balancing market, how and when are imbalances priced? (E.g., Uniform price? Zonal or nodal pricing? Other?)**
- **To what extent is control area consolidation/coordination required to implement the real-time balancing market?**
- **If there is no regional coordination or consolidation by the RTO, how does it provide a real-time balancing market?**

Market for Congestion Management

How does the RTO provide a market for congestion management?

- **Does this market function as a forward market or in real time?**
- **If it functions only during the forward period, how does the RTO operationally manage any residual congestion in real time to ensure that no transmission limit would be violated in any contingency?**
- **How does the model ensure that capacity on congested paths of the transmission system is fully available and used in real-time?**
- **How is the market price for transmission usage (congestion) calculated in the forward market and in real time?**
- **At what time is the price of transmission usage (congestion) made known to transmission users? How can they limit their exposure to price spikes?**

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Transmission Rights

How do the transmission rights work in the model?

- **Are the rights point-to-point, zone-to-zone, flow-based path-by-path, across specified interfaces, other?**
- **What are the incentives for parties to trade/exchange their rights?**
- **How does a party exchange/trade its rights if it decides to change the points of receipt/delivery for its transactions?**
- **Do parties wishing to implement a transaction have to acquire a right and if so, when?**
- **If they do not schedule their rights by some deadline, do they lose or surrender those rights? Are they compensated?**
- **What happens if a party fails to acquire the necessary rights? What is the resulting charge from the RTO?**

Accommodation of Bilaterals/Independent PXs

How well does the model accommodate bilateral and private trading mechanisms (e.g., an APX)? How is this done?

Agenda

- **IndeGO**
- **Physical Rights Models**
- **Financial Rights/LMP Models**
- **California**

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Areas Where FTRs and LMP Are Used

The congestion management and balancing markets used in PJM and New York are based on Financial Transmission Rights (FTRs) and Locational Marginal Pricing (LMP).

- **The LMP at a location reflects the marginal cost of electricity at that location at that point in time.**

New England and the ITCs proposed by Commonwealth Edison and MidAmerican, and Entergy are also proposing markets based on LMP and FTRs.

Congestion Management

Markets based on financial rights and LMP use a version of the bid-based RTO congestion management system described in Session 2 of this workshop. Congestion is managed by the ISO and the market, through submission of voluntary bids and the ISO's use of those bids to redispatch to relieve congestion.

- **Tradable transmission rights are auctioned in advance to allocate transmission to those who value it the most. Parties can trade their rights in various secondary/bilateral markets.**
- **The ISO accepts voluntary bids from market participants and uses those bids to allocate transmission and relieve congestion.**
- **It uses a nodal pricing system for generators, and a zonal (nodal average) pricing system for loads.**
- **The same methods are used to manage inter-zonal and intra-zonal congestion.**

Day-Ahead Market

Both PJM and New York operate a day-ahead market and a real-time market for both energy and transmission. (New England has proposed such a system.)

In the day-ahead market:

- **Generators who wish to sell into the market submit bids indicating the minimum amount they are willing to receive to generate energy.**
- **Loads who wish to purchase from the market submit bids indicating the maximum amount they are willing to pay to consume energy.**
- **Bilateral transaction customers and independent power exchanges submit schedules indicating the amount of energy they wish to transmit, and the locations where they will inject and withdraw that energy.**

Day-Ahead Market

The ISO uses the bids from generators and loads who wish to participate in the day-ahead energy market it coordinates.

It determines the most efficient way to use those generators to meet that load, based on the bids submitted each has submitted.

- **Participants in bilateral transactions may also submit bids.**
- **The bid for a bilateral generator indicates the price below which the transmission customer would prefer not to schedule the generator to operate.**
- **The bids for a bilateral load indicates the price above which the transmission customer would prefer not to schedule the load to consume.**

Day-Ahead Prices

Day-ahead LMPs represent the marginal cost of meeting a small increment of load at each location in the day-ahead market. They are used to settle transactions in the day-ahead market.

- **Consumption that was scheduled in the day-ahead market is charged the day-ahead LMP.**
- **Generation that was scheduled in the day-ahead market is paid the day-ahead LMP.**
- **Balanced bilateral transactions that were scheduled in the day-ahead market pay the day-ahead LMP where they withdraw power minus the day-ahead LMP where they inject power.**

Real-Time Market

Generators and loads that wish to participate in the ISO's real-time market submit bids into that market.

- **These bids may differ from the bids that were made day-ahead.**

Bilateral transaction participants may also submit revisions to their schedules, and they may revise any bids they have submitted.

Real-time LMPs represent the marginal cost of meeting a small increment of load at each location in the real-time market.

- **They are used to settle deviations between the day-ahead schedule and actual injections and withdrawals.**

Bilateral Contracts and the Imbalances Markets

Ready access to the imbalances market greatly facilitates participation in bilateral contracts.

- **It is not necessary to ensure that generation and load are precisely in balance. Small deviations can be purchased from, or sold to, the ISO's real-time market.**
- **If a generator trips, replacement energy can be purchased from the ISO's real-time market.**
  - ***Of course, bilateral customers are always free to arrange their own backup supply if they wish.***
- **And a generator serving a bilateral contract has the option, if it chooses, to produce less energy itself and to purchase replacement energy from the ISO's spot market.**
  - ***It does this by supplying a decremental bid to the ISO. If the LMP at its location is less than its dec bid, it is backed down and it is charged the LMP for replacement energy.***

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Timing of Price Determination

The LMPs for the day-ahead market are announced after the day-ahead market closes, while the LMPs for the real-time market are posted shortly after each hour.

This means that the price that is paid for a given transaction will not be known before that transaction is scheduled.

- **This is often a concern of market participants who would like to know the transmission price before their transactions are scheduled.**
- **Every congestion management system must have some procedure for dealing with the fact that it is not possible to:**
  - ***Ensure that sufficient transmission will be available for all customers who wish to take service at a given price, while also***
  - ***Stating that price in advance.***

Price Risk or Quantity Risk

There are two options.

- **Service can be curtailed (i.e., rationed on a non-price basis) if more market participants want service at the announced price than can be accommodated, or**
- **Prices can increase to a level where demand does not exceed supply.**
- **So there must be either price risk or quantity risk.**

LMP follows the second route.

- **This is consistent with Order 2000, which states that "congestion pricing proposals should seek to ensure that … limited transmission capacity is used by market participants that value that use most highly." (p. 382)**

LMP-based markets contain several mechanisms that enable market participants to hedge these price risks.

FTRs

One such mechanism is an FTR.

- **These are also called financial congestion rights, or FCRs, in New England, and transmission congestion contracts, or TCCs, in New York.**

Ownership of an FTR provides a hedge against transmission usage charges. They are purely financial hedges.

- **Ownership of an FTR is not required in order to schedule transmission service.**
- **Nor is it required for the owner of an FTR to undertake a transaction in order to receive payment.**
- **FTR ownership conveys no ability to control the operation of the grid.**
- **FTR owners are not given any preference when scheduling transactions.**

FTRs as Hedges

Each FTR specifies an injection location, a withdrawal location, and a number of MW.

- **These locations may be buses, zones, or hubs.**
- **They do not specify paths between those locations.**

The holder of that FTR is paid the LMP at the withdrawal location minus the LMP at the injection location, times the number of MW specified for that FTR, in each hour in which that FTR is valid.

- **This perfectly offsets the transmission usage charge that would be incurred in transmitting power from one location to another.**
- **Payments to FTR holders are never curtailed in New York, and are only rarely curtailed in PJM, so the hedge is a good one.**

FTR Hedging Example

If you have a 100 MW generator at location G serving a 100 MW load at location L, and you own 100 MW of FTRs from location G to location L:

- **You will pay transmission usage charges equal to the LMP at L minus the LMP at G, times 100.**
- **You will receive FTR payments equal to the LMP at L minus the LMP at G, times 100.**
- **Your net transmission cost is the cost of the FTR.**

In other words:

- **You pay for the transmission you use.**
- **You are paid for the rights you own.**
- **If the transmission you use matches the rights you own, you have no net obligation other than the cost of acquiring the rights.**

What if the Transaction and the FTR Don't Match?

FTRs can be used to provide partial hedges for a transaction, even if the entity holding the FTRs changes the injection or withdrawal location for its transaction.

- **Again, suppose you purchased 100 MW of FTRs from location G to location L, in anticipation of using your 100 MW generator at location G to serve a 100 MW load at location L through a bilateral transaction.**
- **However, the generator at location G trips. Instead, you use your backup generator at location H to supply the transaction.**
  - ***You will pay transmission usage charges equal to the LMP at L minus the LMP at H, times 100.***
  - ***You will receive FTR payments equal to the LMP at L minus the LMP at G, times 100.***
  - ***Your net cost is the LMP at H minus the LMP at G.***
  - ***If these LMPs are similar, or if they tend to move together, your transmission price risk is still hedged.***

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FTR Allocation Procedure

FTRs have been allocated through a two-step process.

- **In New York, FTRs are first allocated to transmission customers with grandfathered transmission contracts.**
  - ***The FTRs match the injection and withdrawal locations specified in those contracts, and the number of MW they were permitted to transmit under those contracts.***
- **In PJM, FTRs are first allocated in conjunction with network and firm point-to-point service.**
- **The remaining FTRs are made available for purchase in an auction.**
  - ***Owners of pre-allocated FTRs are allowed to offer their FTRs for sale in this auction.***

FTR Auction

The number of FTRs allocated can utilize the entire capacity of the grid.

- **There is no need to withhold transfer capability to ensure that zone-to-zone rights can be honored, no matter where power is withdrawn or injected in each zone.**

The auction permits the points between which FTRs are defined to be determined by bidders' bids in the auction.

- **Therefore, if FTRs between one pair of locations is released into the auction, FTRs between another pair of locations may be defined using that capacity.**
- **This provides an additional incentive for owners of FTRs to release their FTRs into the auction--the released FTRs may make possible FTRs between a different pair of injection and withdrawal locations that someone else values more highly.**
- **The entity releasing the FTRs would benefit from this, because they are paid the market-clearing price for those FTRs.**

Secondary Markets for FTRs

FTRs purchased in the auction or allocated through other procedures can be traded in the secondary market.

- **They can be traded as is.**
- **They can be broken into pieces.**
  - ***An FTR from G to L can be broken down into an FTR from G to another location, and an FTR from that other location to L.***
  - ***These FTRs could then be sold separately, to hedge separate transactions.***
- **Or they can be combined.**
  - ***An FTR from G to another location, plus an FTR from another location to L, can be combined to form an FTR from G to L.***
  - ***This mechanism permits FTRs that were originally intended to hedge one set of transactions to hedge another set instead.***

Market participants who did not acquire FTRs can still achieve day-ahead price certainty by scheduling transactions in the day-ahead market.

Other Hedging Mechanisms

Other mechanisms to assist market participants to hedge risks are also available under LMP.

One such mechanism is a hub.

- **Hubs are not physical locations.**
- **Instead, the price at a hub is the weighted average of the prices at many other locations.**
- **Hub prices are less subject to fluctuations due to unusual outages than are prices at individual locations.**
- **Hubs give market participants common locations at which to trade, permitting a liquid market.**
- **PJM's Western hub is one of the most active and liquid markets.**

Other Hedging Mechanisms

Another hedging mechanism is contracts for differences and similar financial instruments.

- **Since LMPs are publicly posted in New York and PJM, contracts can be written which specify settlements relative to those prices, which can help both parties hedge their risk exposure.**
- **The availability of these prices also makes it easier for market participants, particularly smaller participants, to participate on an equal footing.**

Finally, a third hedging mechanism is PJM's e-Schedules.

- **E-schedules permit responsibility for paying the transmission usage costs associated with physical transactions to be allocated among market participants after the close of the market.**
- **This makes it easier for traders to match their responsibility to pay for these transactions with the transactions that went physical.**

Inter-Control Area Coordination

PJM and New York were already single control areas when they implemented LMP, so no control area consolidation or integration was necessary.

- **However, the eastern ISOs (PJM, New York, New England, and Ontario) are investigating a procedure to coordinate operations.**
- **Currently, the dispatch in each control area only considers the costs of alleviating congestion within that control area. The coordination procedure is intended to reduce the costs that these control areas impose upon their neighbors and to create, in effect, a regional market.**
- **This procedure involves the iterative solution of the dispatch models used by each control area to converge to a common solution.**
- **If RTO West continues to consist of multiple control areas, this mechanism could be used to coordinate the operation of those control areas.**

Agenda

- **IndeGO**
- **Physical Rights Models**
- **Financial Rights/LMP Models**
- **California**

California Congestion Management

California uses a version of the bid-based RTO congestion management system described in Session 2 and 3 of this workshop. Congestion is managed by the ISO and the market, through submission of voluntary bids and the ISO's use of those bids to redispatch to relieve congestion.

- **Annual transmission rights auctions allocate rights for inter-zonal transmission to those who value them the most. Rights can then be traded in secondary markets**
- **The ISO uses a zonal pricing system. It uses different aproaches to manage and price inter-zonal and intra-zonal congestion**
- **It runs a real-time, bid-based market for energy and transmission and hour- and day-ahead markets for inter-zonal transmission**
- **The ISO accepts voluntary bids from market participants and uses those bids to allocate transmission and relieve congestion**
- **Market separation rules apply in the forward markets**

California's Market Differs in Some Ways from Eastern ISO Markets

These differences define several of the key market design choices for RTO West.

- **Unlike Eastern ISOs, CAISO applies a market separation rule in its forward markets. The rules are being relaxed to allow voluntary inter-SC trades, and other revisions are under consideration.**
- **CAISO does not have a real-time economic dispatch objective; Eastern ISOs implement an economic dispatch**
- **ISO/PX use zonal pricing; Eastern ISOs use or are implementing LMP for generators and LMP averaging for most loads**
- **California tends to implement its markets sequentially; Eastern ISOs are moving towards simultaneously integrated markets**
- **California has a separate Power Exchange to implement a bid-based forward *energy* market; Eastern ISOs combine forward energy and real-time balancing markets in the ISO**

California Day-Ahead Transmission Market

The California market separates the day-ahead and hour-ahead markets for energy and transmission

- **The Power Exchange (PX) coordinates a bid-based energy market in the forward periods**
- **The ISO coordinates a bid-based transmission market in the forward periods**

ISO Day-Ahead Transmission Market

The ISO's day-ahead market is triggered by the submission of preferred schedules from various "scheduling coordinators" (SCs). The PX is considered another SC.

- **Each SC submits balanced schedules for its transactions**
- **Each SC can also submit adjustment bids that the ISO can use to relieve congestion in the day-ahead market**

The ISO evaluates the preferred schedules to determine whether they would cause any *inter-zonal* congestion.

- **The ISO ignores *intra-zonal* congestion in the day-ahead and hour-ahead markets**

ISO Day-Ahead Congestion Management

SCs indicate their willingness to pay for transmission through the submission of incremental and decremental adjustment bids.

- **An incremental adjustment bid indicates an SC's willingness to provide additional energy beyond its preferred schedules at a location (e.g., 50 MW @ point B for $40/MWh)**
- **A decremental adjustment bid indicates an SC's willingness to produce less energy from the generator in its preferred schedule. (e.g., 50 MW @ point A for $25/MWh)**
- **The difference in these bids ($40 - $25 = $15/MWh) signals the SC's willingness to pay for transmission from A to B in the event an inter-zonal interface is congested. That is, the SC is saying that if transmission from A to B costs more than $15/MWh, it would prefer to accept redispatch using its incremental and decremental bids, substituting its $40 generator for its $25 generator.**

ISO Day-Ahead Congestion Management

If the ISO determines that the combination of preferred schedules from all SCs would cause congestion across any inter-zonal interface, the ISO considers the adjustment bids submitted by the SCs. The market separation rule applies.

Given the bids from each SC, the ISO can allocate transmission across the congested interface to those willing to pay the most for it.

As the ISO allocates transmission, it also defines the marginal user of that interface. The marginal user's transmission bid defines the marginal cost of using the congested interface (given the market separation rule, which prevents the ISO from considering inter-party trades that might reduce the marginal cost of redispatch).

This marginal cost becomes the "transmission usage charge" that applies to all schedules on that interface.

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ISO Real-Time Congestion Management

In its real-time market, the ISO resolves any remaining congestion, including intra-zonal congestion, in conjunction with its real-time balancing market.

The ISO can consider any unused adjustment bids, and any bids submitted by parties for the real-time balancing market, to solve remaining congestion.

The ISO first solves for *inter*-zonal congestion.

The ISO then solves for *intra*-zonal congestion, subject to not creating any new inter-zonal congestion.

- **The ISO does not apply the market separation rules when solving for intra-zonal congestion**
- **The ISO limits the amount of redispatch to that needed to resolve congestion; it does not continue to find an economic dispatch**

California Transmission Rights

California transmission rights are similar to the rights models described in Session 3, with some differences.

- **Participants can bid to purchase "firm transmission rights" (FTRs) in annual auctions coordinated by the ISO**
- **FTRs are defined as directional rights across an inter-zonal interface**
- **FTRs also give the owner a scheduling priority (over those without FTRs) in the event of "ties" when the ISO is allocating access using adjustment bids**

Parties without FTRs can schedule a transaction

- **In effect, they "purchase" rights (or transmission) by having to pay the transmission usage charge for the inter-zonal transactions they implement**

California Transmission Rights

When there is congestion, owners of FTRs are entitled to compensation, even if they do not undertake a transaction corresponding to those rights.

- **They receive a payment for the transmission usage charge that applies across the inter-zonal interface defined by the FTR**
- **The FTR thus functions as a financial hedge against the TUC for any party scheduling a transaction across a congested inter-zonal interface**

FTRs are directional and are "options."

- **If congestion is in the opposite direction (relative to the FTR) on the inter-zonal interface, the TUC is "negative"**
- **However, a "negative" TUC does not mean the FTR owner has an obligation to pay**

California Market Issues

The ISO is currently undergoing a comprehensive review of its congestion management system, as ordered by FERC. Among the issues under review are:

- **Possible increase in the number of active zones. There are currently only 3 active zones within California; Staff has proposed several more. FTRs may need to be redefined.**
- **Possible further relaxation of the market separation rules. Some parties support allowing the ISO to coordinate voluntary inter-SC trades in the forward markets. Other parties are urging an economic dispatch goal.**
- **Reform of market power mitigation. The ISO is proposing to move from reliance on Reliability Must Run (RMR) units to using bid caps for generators with market power.**
- **Some parties are proposing consideration of nodal pricing and/or voluntary nodal/zonal hybrids.**

Answers to Generic Questions

1. How does the RTO provide open access to a real-time balancing market?

- **The ISO operates a bid-based real-time balancing market. It selects generators in merit order of their bids, subject to congestion. Market separation rules may prevent an economic dispatch.**
- **Imbalance prices are zonal; uniform prices apply in each zone.**
- **The ISO has consolidated the PG&E, SCE and SDG&E control areas.**

Answers to Generic Questions

2. How does the RTO provide a market for congestion management?

- **The ISO coordinates bid-based transmission/congestion markets day-ahead and in real-time.**
- **The ISO uses adjustment bids to allocate transmission across inter-zonal interfaces; it uses adjustment and supplemental (balancing market) bids to redispatch to relieve intra-zonal congestion.**
- **Transmission usage across inter-zonal interfaces is priced at marginal costs; usage for intra-zonal is priced at a uniform charge (uplift) spread proportionally over loads in the zone.**
- **Inter-zonal TUC is known at the close of day-ahead and real-time markets. Parties limit their exposure through bids that indicate their willingness to pay for using a congested inter-zonal interface.**

Answers to Generic Questions

3. How do the transmission rights work in the model?

- **FTRs are specified across inter-zonal interfaces**
- **Parties have incentives to trade rights to match their hedges against their expected transactions, though they are not required to do so. A match insures a perfect hedge.**
- **Parties can trade rights in secondary markets or exchange rights in the ISO coordinated transmission markets. Since the owner is entitled to compensation for the rights it holds, and pays the usage charge for the transmission it uses, the ISO settlement effectively "trades" its rights to match its transactions.**
- **Parties do not have to purchase an FTR to implement a transaction. However, a party must pay the transmission usage charge for any transaction across a congested inter-zonal interface. This is equivalent to having to purchase an FTR for that transaction.**

Answers to Generic Questions

4. How well does the model accommodate bilateral and private trading mechanisms? How is this done?

- **The model accommodates APX and private markets that may be operated by scheduling coordinators.**
- **The model promotes the development of SCs by requiring that all schedules submitted to the ISO be submitted through an SC.**